

Modification of the potential production capabilities of agricultural terrace soils due to historical cultivation in the Budina cadastral area, Slovakia

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Abstract

The soil production attributes of historical agrarian terraced fields were examined in the Budina cadastral area of the Ostrozky Mountains. This landscape represents a unique sub-mountainous Carpathian landscape with farms that use a historically preserved triple-field agricultural system. We determined the geo-spatial parameters of different types of land cover and terraces using geographic information systems. The soil depth was measured in the field, and the skeleton content was determined in the laboratory. We compared data regarding the potential production capabilities of the soil with data from the national classification of agricultural soils. Our results indicated that the soil productivity attributes improved because the naturally less fertile cambisols were positively affected by terracing and long-term cultivation. We recommend the preservation of traditional agricultural activities in historical terraced fields because these terraces represent valuable features that improve the quality of the landscape.

Keywords: Traditional land use, cultivated soils, production capability, physical soil attributes, classification of agricultural soils in Slovakia

1. Introduction

This study focuses on valuable traditional rural landscapes in the sub-mountainous and mountainous Carpathian regions of Slovakia. The period of agricultural collectivisation (1950s–1970s) is regarded as one of the most important periods in terms of landscape development in Slovakia. Traditionally-managed agricultural landscapes, which once covered more than half of the Slovak territory, were transformed into large-scale fields. Only fragments of traditional agricultural landscapes have survived (Lieskovský et al., 2014). Agricultural intensification during the 1970s resulted in the abandonment of traditional agricultural practices, which reduced the biodiversity associated with historical land uses (Bezák and Halada, 2010). Heterogeneous historical agricultural landscapes are disappearing in Slovakia (Olah et al., 2012; Mojses and Petrovič, 2013) and in other European countries (Beilin et al., 2014), such as those in Scandinavia and Iberia. Land cover in traditional agricultural landscapes is heterogeneous, and historical agricultural activities have created conditions that promoted the vast diversity of biotope types (Lindborg and Eriksson, 2004). Zilioli et al. (2011) highlighted the fundamental role that soil science plays in the conservation of natural resources and in achieving sustainable management of mountain ecosystems. The study area considered in this paper surrounds Budina Village in the Ostrozky Mountains of Central Slovakia. Budina was founded in the 14th century during a wave of Wallachian colonisation. Traditional land use persists in this area (Fig. 1).

Frequently, terraced fields are formed by ploughing along contours (Stankoviansky, 2001). Terraces are a valuable feature of the cultural landscape of the study area (Slámova et al., 2013), and are a “landscape-resource” with high potential for sustainable development in many mountain areas (Lasanta et al., 2013). Terracing is used world-wide. The ages of terraces vary between different countries: some of the oldest terraces were established between 7400 and 4000 BC (the Late Neolithic and the Early Bronze Age) in Greece (van Andel et al., 1990); and terraces have been cultivated for 1,500 years in the Colca Valley of Peru (Dick et al., 1994).

Terraces are classified into different categories. Lasanta et al. (2013) observed bench terraces, in which the flat area is delimited in the lower part by a vertical step (a stone or talus wall covered by shrubs or fruit trees). A second type of terrace is represented by small slope gradients that are delimited by herbaceous vegetation, or a wall made from stones that were removed from the field. Critchley and Brommer (2003) documented the existence of bench terraces with small back slopes that allow excess runoff to drain away in countries with high rainfall (approximately 2,000 mm per year). In addition, Doolittle (1990) described important functional and design distinctions of different types of terraces, including hillside terraces and streamside gardens. The study area considered in this research is rich in contoured hillside terraces. These terraces were established primarily for agricultural use in Slovakia during the Walachian colonisation wave between the 14th and 16th centuries (Stankoviansky, 2011).

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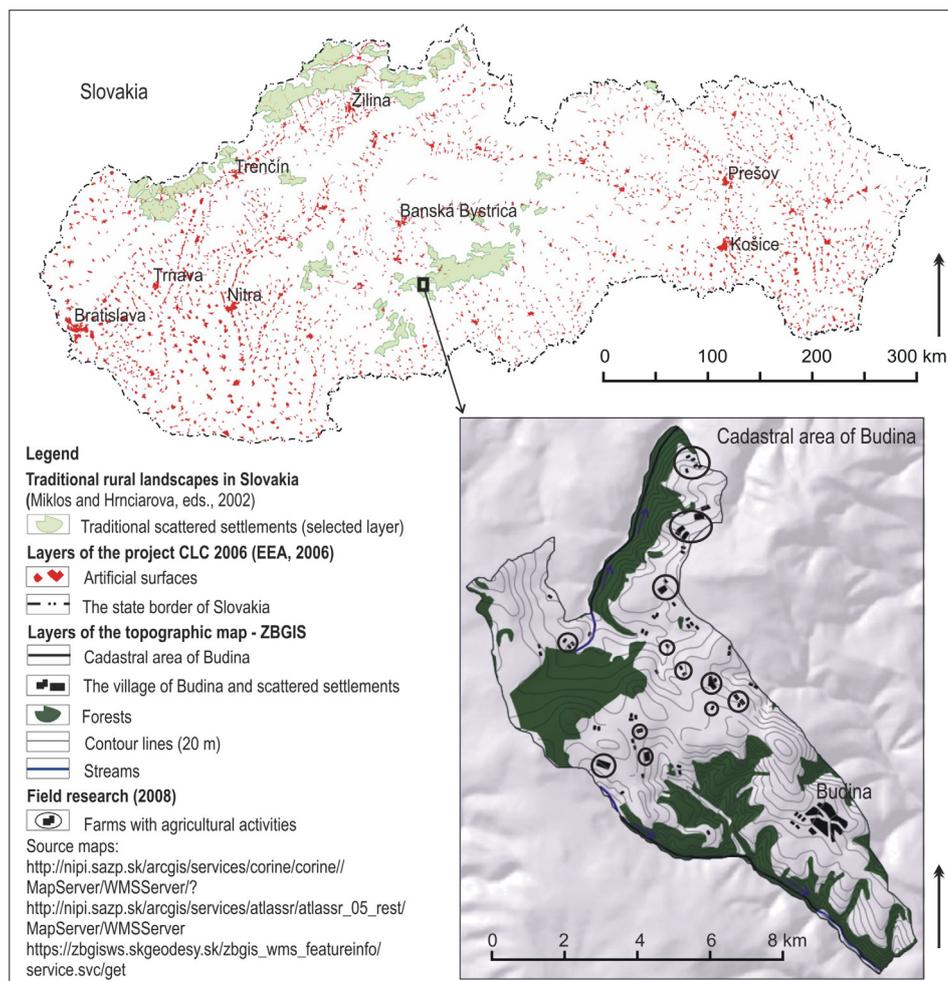


Fig. 1: Locations of the studied cultural landscape types in Slovakia; scattered settlements and farms with agricultural activities in the Budina cadastral area. Source: authors' elaboration

We identified farms that were cultivated in 2008 in the Budina area. Among the marginal agricultural areas in Slovakia, this area provides an ideal opportunity to observe the functional relationships of historical, triple-field agrarian systems, which are rarely used on farms today. The current socio-economic situation and demographic decline have resulted in the abandonment of traditional agricultural practices on terraces (Jakubec, 2011) (see Fig. 2 cover p. 4). The climate in this area is characterised by cold and wet summers. In this region, relatively high rainfall and temperatures ranging from 16–18 °C occur during July, the annual rainfall is 650–900 mm, and the annual mean temperature is 4–6 °C (Miklós and Hrnčiarová [eds.], 2002). The most abundant regional geological formations are neo-volcanic andesitic rocks with prevailing saturated and acid modal cambisols and cultisolic cambisols. Palaeozoic granodiorites are only found in the northern region of the mountains, which corresponds to the region in which ranker soils occur. Cultisolic cambisols cover the studied area, as stated in the Landscape Atlas of the Slovak republic (Miklós and Hrnčiarová [eds.], 2002).

2. Theoretical background

The term “cultisols” is used to classify basic soil ecological units (BSEUs) in Slovakia (Linkeš et al., 1996). BSEUs are relatively homogeneous units with similar ecological conditions for plant cultivation and are the basic units of agrarian land evaluation in the official classification system (Hraško and Bedrna, 1988). Although cultisols are classified

in the official BSEU classification system, we did not find any cultisols in the study area. Terraces do occur, however. According to the World Reference Base for Soil Resources, the term “anthrosols” is used for cultivated soils. The parent material of anthrosols represents any soil material that has been modified by extensive cultivation or the addition of materials. The influences of humans are normally restricted to the surface horizon, but a buried soil may still be intact at some depth (IUSS Working Group WRB, 2006). Anthrosols include subtypes that have been studied by many authors, including those who have studied “plaggen soils” (Blume and Leinweber, 2004; Kalinina et al., 2009).

Generally, the topic of soils on historical agrarian terraces is not discussed broadly in Slovakia. Soils modified by human activities, however, have been the subject of several studies (Sobocká, 2011). Linkeš et al. (1996), the main authors of the manual for applying BSEU characteristics in practice, define cultisols as soils that have been substantially transformed by human activities, such as deep soil loosening and mixing of the soil profile, which are often associated with the construction of terraces. Krnáčová et al. (2013) define anthrosolic and cultisolic rendzinas, carbonate and lithosolic anthrosols and other soil subtypes in the study areas of traditional agricultural landscapes.

This research project considers the potential production capabilities of cultivated agricultural soils on historical terraces. Senjobi et al. (2007) showed how traditional farming practices affect the productive potentials of soils.

Several studies have discussed the improvement of soil attributes in historical agrarian terraces with long-term cultivation (Ciampalini et al., 2008; Goodman-Elgar, 2008; Ramos et al., 2007). Chen et al. (2012) documented why poor management and abandonment of terraced paddy fields result in major increases in soil erosion in mountainous areas. Antle et al. (2006) studied terraces in Peru and demonstrated that human activities are important driving factors behind soil formation that may positively or negatively affect soil productivity.

The potential production capability of agricultural soils in Slovakia is expressed in terms of the potential production categories or typologies of agricultural soils (Džatko, 2002). In our case, however, in which BSEU units do not refer to cultivated soils and cultisols on terraces only describe primary natural soils, we must establish whether the potential production capabilities of agricultural soils defined in the official typology reflect the current production potentials of cultivated soils in terrace systems. Furthermore, the typology provides recommendations on how to use agricultural soils within landscape-ecological limits.

We formulated the following two objectives for this research project: (i) to demonstrate the relationship between historical soil cultivation and the soils' current production capabilities based on selected physical attributes of the soil; and (ii) to propose amendments to the current classification system of agricultural soils in Slovakia to provide adequate financial subsidies.

3. Data and methods

3.1 Analysis of land-cover structures

The land cover structures used in this paper were analysed as part of a PhD thesis (Jakubec, 2011). We divided the agrarian structures into the following categories: ploughland on historical terraces (P-HLS-terraces); ploughland-fallow on historical terraces (PF-HLS-terraces); ploughland (P); ploughland-fallow (PF); intensively and extensively used grassland (G-1); grassland with a reversible succession to agrarian land use (G-2); grassland with irreversible succession to agrarian land use (G-3); mowed meadows; pastures; orchards; gardens; and wooded non-forest vegetation. The land uses of the studied agricultural plots are indicated in the European "Land Parcel Identification System" (LPIS). During the field research, however, we identified several agricultural plots that were not included in the LPIS. We included these plots as land-cover structures with agricultural land use; however, they were not considered when reclassifying the types of production categories.

All of the maps were analysed using GIS applications, including Quantum GIS Lisboa 1.8.0, which was released under general public licence, and ArcGIS 10.0TM (this software is multi-licensed). Ortho-photomaps were produced in 2010 by TU Zvolen for the CEX ITMS 26220120069 project and had a resolution of 0.2×0.2 m. Historical materials (aerial survey photographs, 1949) were provided by the Topographic Institution, Banská Bystrica (under student licence contract No. TOPU-90-16/2011, for PhD thesis work (Jakubec, 2011).

3.2 Evaluation of the potential production categories of agricultural soils

We vectorised the raster maps of the BSEU, which are available at <http://www.podnemapy.sk>, and created vector

files of the BSEU polygons. Our research considered BSEU attributes, which are expressed in codes. In addition, we studied the soil depth and skeleton content. The collected parameters were classified and evaluated according to a guidebook (Linkeš et al., 1996). We used the following slope categories: very steep slopes ($17\text{--}25^\circ$) that are not suitable for agriculture; steep slopes ($12\text{--}17^\circ$) that are suitable for grasslands; moderate slopes ($7\text{--}12^\circ$) that are suitable for limited ploughland alternating with grasslands; gentle slopes ($3\text{--}7^\circ$) that are suitable for ploughland with few limits; planes with the possibility of water erosion processes ($1\text{--}3^\circ$) that are suitable for ploughland with few or no limits; and planes without the possibility of water erosion processes ($0\text{--}1^\circ$) that are suitable for ploughland without limits. Furthermore, we used the following categories for depth: deep soils (more than 60 cm), medium-depth soils (60–30 cm) and shallow soils (less than 30 cm). The skeleton content is expressed by weight. We used the following categories: no skeleton content (0) (up to a depth of 60 cm, no more than 10%); low skeleton content (1) (5–25% in the surface horizon, 10–25% in the subsurface horizon); moderate skeleton content (2) (25–50% in the surface and subsurface horizons); and high skeleton content (3) (25–50% in the surface horizon and more than 50% in the subsurface horizon).

The main soil types were divided into the following production categories according to the expected agricultural land use: moderately productive (P2) and slightly productive (P3), slightly productive ploughland alternated with highly productive grasslands (P3G1), highly productive grasslands (G1), moderately productive grasslands (G2), slightly productive grasslands (G), and agricultural soils that were not suitable for agricultural activities (N) (Džatko, 1981).

3.3 Field and laboratory research of the selected physical attributes of the soil samples

Field research was performed according to the handbook for mapping soils in the field (Čurlík and Šurina, 1998). We evaluated five terraces in June and July 2012 and calculated the arithmetic averages of each parameter for the terrace.

The selected attributes were described as a range, and the maximum depth at which the soil samples were collected was 30–35 cm. The soil depth was detected manually using an iron bar. The iron bar was marked in 10-cm intervals using a graduated scale, with a maximum measurable depth of 60 cm. When bedrock was not encountered at a depth of 60 cm, the depth of the soil was recorded as "more than 60 cm". The heights and widths of the terraces were measured using a measuring tape, and the slope grade was measured using a Suunto clinometer (PM-5/1520). Exposure and terrace length were analysed in GIS, and eight samples were collected from each terrace (40 total samples). The soil samples were obtained from agricultural terraces using a spade and were collected in a bag for further analysis in the laboratory. Bags containing soil had weights of 4.70–10.10 kg, with an average weight of 7.14 kg.

First, we evaluated the weight of the dried field soil samples in the laboratory. We separated the fine soils from the samples by passing the soil through a 2-mm sieve without grinding any primary particles. The remainder of the sieved soil sample consisted of skeletons. Previously authors have used the following skeleton categories: gravel fraction (2–32 mm), rocky fraction (32–256 mm) and boulders (more than 256 mm). Regarding the influences of cultivation on

the skeleton content in agricultural soils, we separately evaluated the relative skeleton content with a size fraction of more than 32 mm and the relative skeleton content with a size fraction of 2–32 mm, which was not removed during cultivation. Špulerová et al. (2013) noted reduced amounts of skeletons and a poor representation of the skeleton categories in soils in terraced fields. We are interested in the removal of the rock and boulder fractions from the fields. Therefore, we compared the differences between the relative amounts of skeletons in the soil samples within these two groups (different values were expected).

We used the skeleton content evaluation method of Šály and Ciesarik (1991). The skeleton content was calculated from the relative percentage weight of the soil sample [%] using the following formula: $A = (C \times 100) / N$, where A is the relative weight of the skeleton content, N is the weight of the unified soil sample between 500 g and 5,000 g, which is denoted as the solid phase [g], and C is the weight of the exsiccated skeleton. The weight of the 2–32 mm skeleton fraction was evaluated for a unified weight of 500 g. The weights of skeletons larger than 32 mm were evaluated for the entire soil sample because larger skeleton fractions in the soil samples could be heavier than 500 g. Before analysis, a sample was homogenised to obtain a representative soil sample. Approximately 500 g of a representative sample was collected from a larger sample by quartering.

3.4 Reclassification of the potential production categories of terraced agricultural soils

We compared the soil attribute data and terrain parameters, which were collected in the field and analysed in the laboratory, with the data that were included in the classification of agricultural soils. We expect the two following possible combinations of potential production on agricultural soils and land use on ploughland plots: (i) agreement with the limits of the plots used as ploughland (P2; P3), which are recommended for use as potential ploughland or ploughland that is alternated with grasslands; and (ii) discrepancies with the limits on ploughland plots that are used as ploughland while classified as grasslands or as not suitable for agriculture activity. Based on field and laboratory results, we suggest a hypothetical re-classification of land use for historical agrarian terraces.

4. Results

4.1 Historical terraces in the land-cover structures

All of the agricultural plots with the agricultural soils that were evaluated in the next step were listed in the LPIS and accounted for 931.21 ha (54.39%) of the cadastral area in 2010 (bold letters in Tab. 1). Grasslands prevailed across the agricultural landscape, accounting for 801.93 ha

Land-cover structures	1949		2010	
	Relative area [%]	Absolute area [ha]	Relative area [%]	Absolute area [ha]
1. Hard surfaces	1.06	18.11	0.73	12.56
2. Forests	14.17	241.15	36.44	623.92
3. Wooded non-forest vegetation – points	0.34	5.74	0.10	1.75
4. Wooded non-forest vegetation – lines	0.98	16.73	2.96	50.67
5. Wooded non-forest vegetation – areas	1.88	31.96	3.80	65.11
6. Ploughland	-	-	1.52	26.00
7. Ploughland on historical terraces	35.5	604.42	1.79	30.66
8. Ploughland – fallow	-	-	1.43	24.48
9. Ploughland – fallow on historical terraces	-	-	0.46	7.78
10. Services and buildings	0.06	0.99	0.07	1.14
11. Gardens in scattered settlements	1.25	21.35	1.88	32.01
12. Gardens in compact settlements	0.43	7.28	0.48	8.24
13. Rocks and exposed substrate	1.11	18.96	0.26	4.40
14. Grassland with ruderal vegetation	-	-	0.26	4.44
15. Grassland-1 (intensively and extensively used)	35.54	604.98	28.30	484.55
16. Grassland-2 (succession, reversible to agrarian land use)	5.92	100.82	14.94	256.01
17. Grassland-3 (succession, irreversible to agrarian land use)	1.19	20.23	3.33	56.93
18. Streams	0.07	1.11	0.08	1.43
19. Agricultural buildings	-	-	0.50	8.54
20. Compact settlements	0.34	5.74	0.43	7.44
21. Scattered settlements	0.16	2.77	0.24	4.04
<i>Total</i>	<i>100.00</i>	<i>1,702.34*</i>	<i>100.00</i>	<i>1,712.10*</i>

Tab. 1: Comparison of the total area of land-cover structures in the cadastral area of Budina (1949, 2010). Note: *The difference between the total areas of land-cover structures in the current (2010) and historical aerial survey photos of 1949 is 0.58 %. This error arises from uncertainty in the geodetic data that were derived from historical aerial survey photos and occurs because several structures could not be identified from the historical aerial photos.

Source: authors

(46.83%) in 2010. The 931.21 ha of agricultural land that was identified in 2010 corresponded to 427.87 ha less land than the area that was present in 1949, which were 1,359.08 ha (79.84%). Ploughland covered a total area of 88.92 ha (5.19%) in 2010, and covered 604.42 ha (35.51%) in 1949. Ploughland on the historical terraces only represented 38.44 ha (2.25%) in 2010 (shaded in Tab. 1). The abundance of individual categories of land-cover structures in 1949 and 2010 is documented in Tab. 1.

4.2 Potential production categories of agricultural soils

Soils that were potentially suitable for moderately productive ploughland (P2) and slightly productive ploughland (P3) accounted for 465.69 ha (27.2%) of the cadastral area. Slightly productive ploughland alternated with highly productive grassland (P3G1) and covered 99.47 ha (5.81%) of the cadastral area. Highly productive grasslands (G1) covered 253.39 ha (14.8%) of the area, and the remaining area was covered by agrarian land (366.39 ha, i.e., 21.4%), which corresponded to moderately and slightly productive grassland (Fig. 3).

4.3 Field and laboratory research results

The terrace parameters are described in Tab. 2. The average terrace altitude was 714 m a.s.l., which is not suitable for agricultural land use in Slovakia due to the climatic conditions, as shown by the BSEU codes. Two terraces have southeast-facing exposures, two terraces have southwest-facing exposures and one terrace has a northeast-facing exposure. During the field research, we identified the heights of the terraces, which averaged 1.62 m. We found that the maximum slope grade of the terraces is relevant to the critical slope grade, which is optimal for cultivation and planting without creating erosion risks due to water movement. The width of the terraces ranged from 8 to 20 m (average 14.67 m), and the slope of the terraces ranged from 0.14 ° to 1.85 ° (planes with or without the possibility of erosion processes) (Tab. 2).

These slope values were different from the natural slope of the surrounding area, which ranged from 7 ° to 25 °. We observed no relationship between soil cultivation and soil depth, and all of the soils were naturally deep. Deep sandy and loamy cambisols are typically found on andesitic and crystalline granodiorite rocks. When we compared our skeleton content data that were obtained in the field with data from the official classification, we observed several consistencies. Detailed analyses of the skeleton content demonstrated that four of the five localities (No. 2, 3, 4 and 5) were disproportionate relative to the gravel fraction (2–32 mm) contents and the relative rocky fraction (33–256 mm). At these four locations, the gravel fraction was more common than the rocky fraction. Locations 2, 3 and 5 had relatively lower rocky skeleton contents (i.e. 20.34%, 15.08% and 11.89%, respectively) than what was described in the official classification, which ranged from 25% to 50% (Tab. 2). The official classification does not differentiate between the skeleton-gravel fraction and the rocky fraction; however, these results confirm our assumption that the rocky fraction could be removed from agrarian fields during cultivation. The largest rocks were 50 mm, and no boulders were found in the soil samples.

4.4 Reclassification of agricultural soils on historical terraces

In 2010, agricultural land decreased in area and ploughland became scarce compared with 1949. Thus, we decided to present hypothetical proposals for reclassifying agricultural soils, which were originally classified based on their use in 1949. We evaluated plots that were used as ploughland in 1949 and classified them into the potential production category types. Ploughland with optimal land use without limits accounted for 204.64 ha (34.77%) of the plots, while ploughland with optimal land use with limits accounted for 34.07 ha (5.79%) of the plots. Thus, these categories could be used as ploughland alternated with grassland. Moreover, 308.85 ha (52.48%) of the ploughland were not

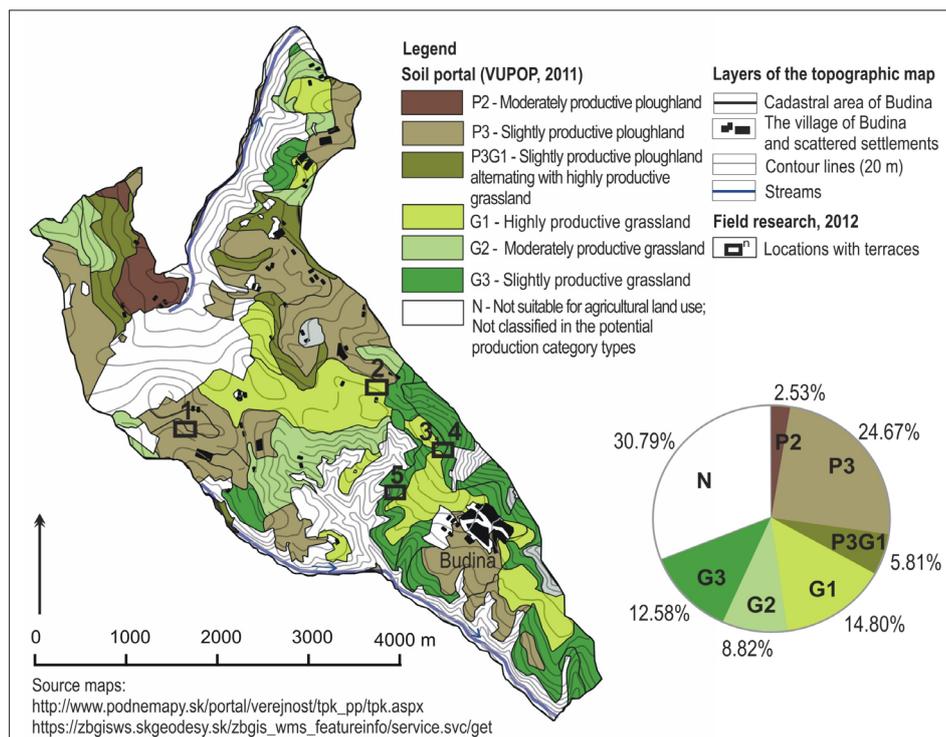


Fig. 3: Production category typology (VUPOP, 2011) for agricultural soils in the cadastral area. Source: authors

Localities		1	2	3	4	5
BSEU codes	Soil skeleton content classes	Poorly skeletal (5–25%)	Moderately skeletal (25–50%)	Moderately to highly skeletal (25–50%)	Moderately to highly skeletal (25–50%)	Moderately to highly skeletal (25–50%)
	Soil depth classes	Deep (60 cm or more)	Medium depth (30–60 cm)	Deep (60 cm or more and locally shallow (less than 30 cm)	Deep (60 cm or more) and locally shallow (less than 30 cm)	Deep (60 cm or more) and locally shallow (less than 30 cm)
	Slope grade classes	Moderate slope (7–12°)	Gentle slope (3–7°)	Steep slope (14–17°)	Very steep slope (17–25°)	Steep slope (14–17°)
	Climatic region classes	Cold and wet	Very cold and wet	Cold and wet	Cold and wet	Cold and wet
	Main soil unit classes	Cambisol typical on andesitic rocks	Cambisol typical on andesitic rocks	Cambisol typical on crystalline rocks	Cambisol typical on crystalline rocks	Cambisol typical on crystalline rocks
	Production category types*	P3	G1	G3	G3	G3
	Relative weight of skeleton content [%]	15.22	27.22	44.49	38.67	30.86
	Relative weight of skeleton content more than 32 mm [%]	49.75	20.34	15.08	31.28	11.89
	Relative weight of skeleton content in the range 2–32 mm [%]	50.25	79.66	84.92	68.72	88.11
	Soil depth [cm]	54	59	59	>60	>60
Slope grade [°]	0.75°	1.34°	0.14°	1.85°	1.28°	
Production category types after reclassification	P2	P3G1	P3G1	P2; P3; P3G1	P3; P3G1	
Additional terrace parameters						
	Length/width/height (average) [m]	417.67/17.4/1.5	168.P3/ 19.6 /2	337.98/8.72 /1.66	156.44/22.6 m in the wider area and 9.3 in the narrower area / 1.55	259.27/10.41/1.4
	Exposure/altitude [m] ASL	SW/730	NE/723	SE/716	SE/708	SW/646

Tab. 2: Terrace parameters collected in the field in 2012. Note: * P2 – moderately productive ploughland; P3 – slightly productive ploughland; P3G1 – slightly productive ploughland alternating with highly productive grassland; G1 – highly productive grassland; and G3 – slightly productive grassland

Source: authors

used in accordance with the potential production category type, and the predominant suitable land use type should be grassland. In addition, 6.96% of the ploughland fell outside of the LPIS (Fig. 4a).

Considering the modified, sloping terrain and the soil conditions on the terraces, we enumerated the following potential land uses of the agricultural landscape in the cadastral area from 1949. Optimal land use of ploughland without limits accounted for 237.12 ha (40.29%) of the plots, and an optimal land use of ploughland with limits accounted for 307.94 ha (52.33%) of the plots. This category could be used as ploughland that alternated with grasslands. Comparing this production category with the situation in which the changed parameters of the cultivated soils were ignored suggests that an additional 273.87 ha could be used as ploughland that is alternated with grasslands. Only 2.50 ha (0.43%) was not suitable for ploughland or ploughland alternated with grasslands. This land should be classified as grassland or as unsuitable for agricultural activities (Fig. 4b).

5. Discussion

The construction of terraces varied in the study area. We found it interesting that the high terraces (approximately 2 m and more) were not constructed as dry-stone walls but were formed by long-term ploughing (Fig. 5 – see cover p. 4). No relationship was observed between soil cultivation and the soil depths. Furthermore, we did not observe any pronounced differences between the skeleton contents as defined in the BSEU codes and as evaluated in the soil samples. Our detailed analyses, however, indicated that the gravel fraction prevailed over the rocky fraction and that boulders were not present in the soil samples. Additionally, we found substantial differences between the slope-grade data that were included in the potential production categories of the soil and the data that were collected in the field. According to our results, terraces have an optimal slope grade for arable soils (planes or gentle slopes with little to no risk of water-based erosion). Thus, we concluded that human inhabitants have improved the soil conditions, primarily by removing the rocky fractions from agricultural terrace soils.

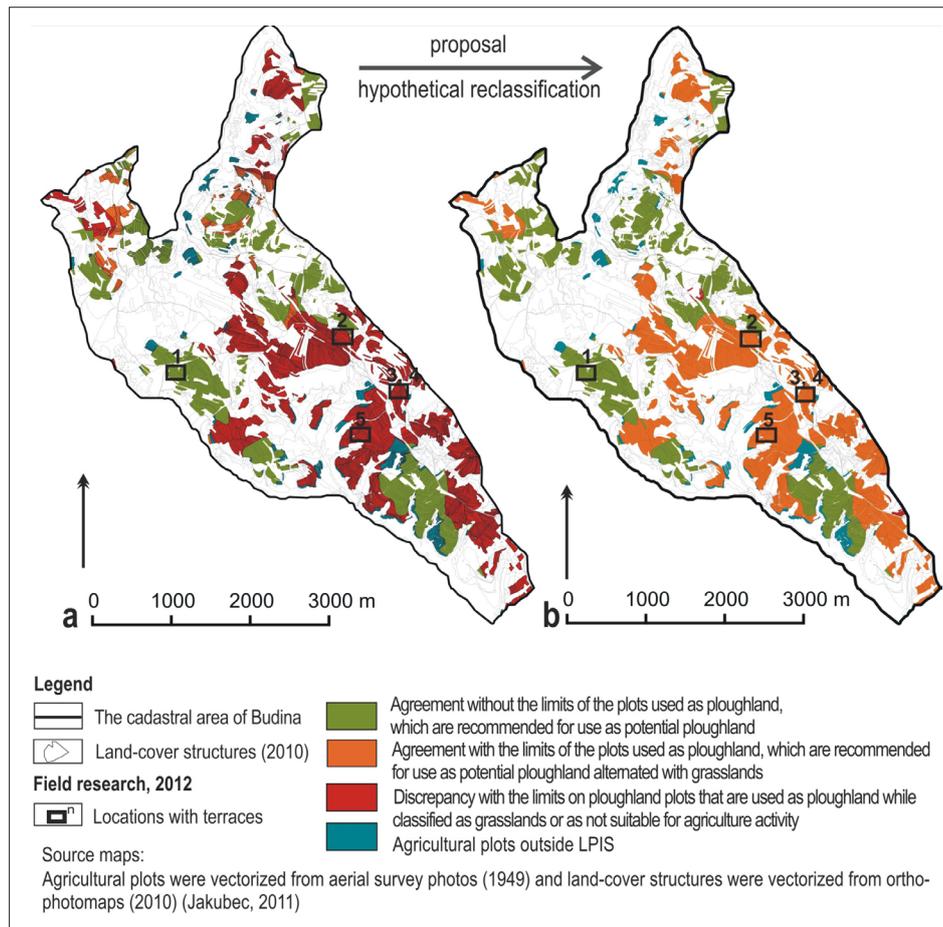


Fig. 4: Evaluation of ploughland plots (1949) for the production category types (a), and the hypothetical reclassification of ploughland plots (1949) for the production category types (b)

Source: authors

In addition, we concluded that only a small fraction of agricultural soils has exhibited over-limited land use based on the hypothetical reclassification map of the agricultural plots. According to the production-category map which was developed according to the criteria of the official classification, over-limited land uses account for 308.85 ha of agricultural soils (Fig. 4a). On the other hand, according to the proposed reclassification (Fig. 4b), only a small portion of agricultural soils (2.50 ha) exhibited over-limited land use.

Kaluz and Šimonides (2000) highlighted the risk of data inaccuracy in BSEU codes. Based on the data collected in the field (Tab. 2), the relevant potential BSEU code does not exist for the agricultural soil type found on the terraces in the cadastral area of Budina. The explanation for this finding is simple. The BSEU codes were established as combinations of natural conditions in regions that typically include agricultural activities; however, the studied area is not a typical agricultural region. Cambisols are typical in agricultural sub-mountainous and mountainous regions in Slovakia (Vilček, 2007). Thus, we propose that cultivated soils on terraces should be classified as cultisols (Linkeš et al., 1996) or cultisolic cambisols (Miklós and Hrnčiarová, [eds.], 2002), according to available official maps. Alternatively, both of these terms could be replaced by a term from the international classification of soils WRB, anthrosols (IUSS Working Group WRB, 2006), and a relevant subtype in this group. We recommend creating a new BSEU code for cultivated terrace soils in the study area.

Land evaluation, which attempts to predict the land behaviour for each particular use, is distinct from soil-quality assessment. In addition, because the biological parameters of a soil are not considered by land evaluation, agro-ecological land evaluation has much to offer (Rosa, 2005). We have evaluated several soil physical attributes in this study. Matečný et al. (2010) have explained, however, how soil-ecological unit parameters are implemented in the financial soil-evaluation process, through several case studies. This relationship demonstrates the importance of adequately classifying soils.

Pardini and Gispert (2012) documented transformation processes in agricultural areas where the colonisation of disorganised spontaneous vegetation has buried a valuable rural patrimony. An interesting view on the application of land evaluations, including soil evaluations, was reported by Fu et al. (2014). These authors proposed using land-use delimitation of the available marginal land for growing energy plants in compliance with the principle that bioenergy development should not compete with cropland and ecologically protected land. The maintenance of traditional land uses and cultural practices that are sustainable should be considered for designing management strategies that are oriented towards conserving landscapes and biodiversity (Stobbelaar and van Mansvelt, 2000). Preserving farms with the unique triple-field system in the study region is important in the cadastral area of Budina. Slámová et al. (2013) studied the same area and reported a heterogeneous agricultural landscape (i.e., a semi-natural agricultural landscape with a

high inner level of heterogeneity that has transitioned into homogeneous forests). Terrace soils are distinctive features of the agricultural landscape in Europe. Due to their historical and aesthetic significance, terraces are a resource for agriculture and tourism; however, they also pose challenges for land conservation and management (Stanchi et al., 2012).

6. Conclusions

By considering the climatic conditions in the study area, we can pragmatically suggest that grasslands are more suitable than ploughlands on terraces. The agricultural landscape considered in this research project is located in a cold and humid climatic region, which strongly limits agricultural activities. With respect to the soils in this area, we expected that additional over-limited agricultural soils would not appear in the cadastral area after the agricultural plots were spatially and functionally optimised. We propose reclassifying the production categories of agricultural terrace soils using specific production category types because the BSEU parameters determine the process of valuing soil. These parameters should be corrected to achieve suitable financial support for agriculture. With these results, we aim to create a vision for the sustainable use of historical terraces by employing innovative agri-technical practices. Currently, agrarian terraces require financial support for retention. Regions with naturally disadvantaged production are significantly supported by agri-environmental payments in Slovakia. We do not consider this manner of allocating subsidies to agriculture sustainable; however, agri-environmental payments are useful in the initial phases of agricultural revival. Historical agrarian terraces represent characteristic features of the landscape because these terraces support the heterogeneity and biodiversity of sub-mountainous landscapes. Thus, we should preserve the diversity of European landscapes as a common resource of natural and cultural heritage, as defined by the European Landscape Convention (Council of Europe, 2000) that Slovakia adopted in 2005.

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